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ABSTRACT

This document presents the findings of the Task Force on Technology Competence, which was formed to determine what every Minnesota high school graduate should know about technology and how technology education should be integrated into the elementary and secondary school curriculum. In chapter 1, technology competence (TC) is defined as "students' ability to apply knowledge, tools, and skills to solve practical problems creatively, extend human capabilities, and evaluate the impact of technology on themselves and society," and a conceptual framework for TC is outlined. In chapter 2, the scope of TC is defined as including not only knowledge and skills expressed through proficiency but also attitudes and values necessary to use technology in an ethical manner, and 13 world-view and practice attributes deemed necessary for Minnesota high school graduates relative to TC are described. Chapter 3 outlines 14 sample learning activities designed to help learners understand the interdependence of and demonstrate/apply the 13 world view and practice attributes of technology. Chapter 4 presents five major findings regarding for integrating technology education into the curriculum and four suggestions for doing so. Appended is the task force membership roster. (MN)

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ED 372 207

State Council on
Vocational Technical Education
STATE OF MINNESOTA

Technology Competence: Learner Goals for All Minnesotans

Report of the Task Force on Technology Competence

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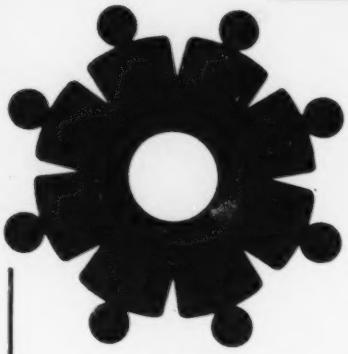

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Technology Competence: Learner Goals for All Minnesotans

Report of the Task Force on Technology Competence

Prepared by
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1992

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Council Prologue

The State Council on Vocational Technical Education expresses its commendation and appreciation to the Task Force on Technology Competence for the contribution to teaching and learning it makes with this report on *Technology Competence: Learner Goals for All Minnesotans*. The Council cites the substantial commitment made by the task force in laying out the learner goals for technology competence. It was a commitment not only to give time and effort but also to share and examine many sound ideas and valued perspectives. Because these commitments were made and kept by the members of this task force, this report represents a highly successful collaborative undertaking of the public and private sectors.

The Task Force on Technology Competence was charged with answering two questions: (a) What should every Minnesota high school graduate know about technology? (b) How should education about technology be integrated into the curriculum of the elementary and secondary schools?

The Task Force on Technology Competence was charged with answering two questions: (a) What should every Minnesota high school graduate know about technology? (b) How should education about technology be integrated into the curriculum of the elementary and secondary schools? In its report, the task force answers these questions. In so doing, the task force advances the work of the Minnesota Department of Education to implement a contemporary vision for vocational education in Minnesota's schools. This vision was articulated in *A Restructured Model for Secondary Vocational Education*, the Department's report to the Governor and1989 Legislature. Central to the restructured model are five new curricular priorities calling for learning opportunities for all students in (a) career development, (b) work readiness, (c) preparation for family roles, (d) technical skills, and (e) technology competence.

The restructured model distinguishes between curricula for technical competence and technical skills. In the restructured model, the technical skills curriculum is laid out specifically for students preparing directly for work and future advanced skill training. The restructured model envisions opportunities for technical skills education being available to all students. Whether students avail themselves of these opportunities would be their choice.

Technology competence, on the other hand, is approached quite differently. The restructured model says that opportunities to learn about technology are to be *available* and *included* as part of the education of *all* students. In addressing the concept of technology competence in the restructured model, the Minnesota Department of Education recommended to the Governor and Legislature that the curricular objectives be "for *all* students to use technology effectively and thoughtfully in all education and lifelong learning experiences."

The Minnesota Department of Education requested that the Council undertake this project to develop the learner goals for technology competence. The project was supported in part by a grant from the Department with funds provided by the Legislature specifically for research and development on the restructured model. To carry out the project, the Council established the Task Force on Technology Competence to avail itself of the expertise of both the education and business communities. In producing this report, the task force gave clear and sound direction to Minnesotans to realize technology competence for all high school graduates.

The Council encourages the implementation of these learner goals as part of the learner outcome based system under development by the State Board of Education. In making this recommendation, the Council expresses its belief that this report serves the best interests of Minnesota youth and of the state as a whole. Quite simply, the implementation of this report is of the utmost importance to the educational and economic well-being of the people of Minnesota.

"Technology means more, far more," the Task Force on Technology Competence asserted, "than learning with or about computers or the ability to use any device, machine, or tool." The view of the task force is that "technology is a body of knowledge, a field of study, a substantive curriculum, and a pervasive force relevant to all aspects of human endeavor." With this statement, the task force set the tenor and tone of its approach to advancing the implementation of the restructured model.

The Council endorses the learner goals for technology competence put forth in this report. Indeed, the Council encourages the implementation of these learner goals as part of the learner outcome based system under development by the State Board of Education. In making this recommendation, the Council expresses its belief that this report serves the best interests of Minnesota youth and of the state as a whole. Quite simply, the implementation of this report is of the utmost importance to the educational and economic well-being of the people of Minnesota.

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Chapter One

Defining Technology Competence

Education and Technology

Technology is a body of knowledge, a field of study, a substantive curriculum, and a pervasive force relevant to all aspects of human endeavor. Technology competence means more, far more, than learning with or about computers or the ability to use any device, machine, or tool.

Technology is a body of knowledge, a field of study, a substantive curriculum, and a pervasive force relevant to all aspects of human endeavor. Technology competence means more, far more, than learning with or about computers or the ability to use any device, machine, or tool. Technology is perhaps best defined as a process whereby knowledge, tools, and skills are applied to solve practical problems and extend human capabilities. Technology is often thought of in terms of the products it creates and their effects on society.

Nearly every aspect of modern life is touched by the products and byproducts of technology. Concerns over the quality of the water we drink, the food we eat, and the condition of the built and natural environments we inhabit are directly related to the development and use of technology.

Technology becomes more pervasive with each passing year, and the rate of technological development continues to increase. The technological knowledge base is said to be doubling every ten years (every 18 months in computer and telecommunications technology). This means that the amount of knowledge generated in the next ten years will equal all that is known today.

This accelerating pace of change affects not only the lives of individuals but also the destinies of whole nations. The globalization of markets has been brought about by advances in the technologies of communication and transportation. The pace and scope of technological development challenge all of our social, economic, and political institutions. Now, more than

ever, wise consideration of the use and development of technology is required to ensure the well-being of all of us and the planet which we share.

Among the most important challenges we face is deciding what to teach young people about technology. Technology deserves direct consideration in every subject taught in school. Surprisingly, technology has no well defined place in the curriculum taught most students. This condition exists despite the fact that technology is so pervasive and all encompassing that it creates values, sets public policy agendas, shapes careers, and determines our quality of life. In order to understand modern life, students need to grasp the possibilities and limitations of technology. A major challenge in making the study of technology accessible to students is identifying the concepts which make it a distinct field of knowledge.

Surprisingly, technology has no well defined place in the curriculum taught most students. This condition exists despite the fact that technology is so pervasive and all encompassing that it creates values, sets public policy agendas, shapes careers, and determines our quality of life.

As a field of knowledge, technology is "know how" as opposed to the "know what" (or "know that") on which education has so often focused to the exclusion of the other. Science and technology are tightly interwoven, with the questions of science often answered through the use of technology. Whereas the questions of science are "what is it like?" (i.e., the surface of Mars) and often "why is it like that?" the central question of technology is "how can this be done?" This does not mean technology is not concerned with what and why, but that its primary goal is to understand processes and to achieve practical results.

Most learning about technology has traditionally taken place in the curricula of industrial arts, vocational education, and some science classes. A key element of these courses is an emphasis on the experiential learning process which takes place in school laboratories and in hospitals, factories, businesses, and agencies throughout the community. The Task Force on Technology Competence strongly advocates this approach to learning and champions the expansion of the opportunities for students to learn by doing. Indeed, this is a desired result of curricular reform leading to technology competence.

In addition to the curricula of industrial arts, vocational education, and science, technology can be a part of all subject areas, as has been demonstrated by many innovative teachers of social studies, mathematics, and the language arts. In Minnesota, more widespread integration of learning about technology into the curricula will require: (a) increased emphasis on technology as a legitimate subject for study, (b) specific

objectives for learning about technology, and (c) the resources required to support major efforts in curriculum development and the professional development of teachers.

The effort to integrate learning about technology into the curriculum has important implications for the restructuring of the schools. The isolation of traditional subject areas from one another clearly needs to be lessened for an integrated curriculum to succeed. The approach envisioned by the task force calls for teams of teachers working together to bring this about. The way blocks of time are used during the school day must also be examined and lengthened as necessary to provide sufficient time for students to learn efficiently and effectively through laboratory and field experiences.

Student assessment and evaluation procedures are areas of particular concern for the task force. Members of the task force agreed that the high school diploma provides little useful information to those making hiring decisions. Systems for evaluating student performance need to be improved to enhance the reliability of the information available to students, parents, teachers, and employers. Portfolios of student work coupled with written assessments of student performance are strongly supported by the task force.

As important as the notion has been that Minnesotans must be in control of their future, never have the consequences of not being so as great or long-lasting as they are today. Minnesota simply cannot afford to forego the learner goals for technology competence laid out in this report.

Looking ahead, it is apparent that change will continue to be the only constant, both within our nation and throughout the world. In many ways, the problems we face today and in the future both will be caused and solved by the development and use of technology. The increasing diversity of our society, reflected in today's school children and youth, create new challenges for education. The world that these young people face upon graduation will require new knowledge and skills for meeting family and work responsibilities. This includes basic competency in the use of technology, as well as an understanding of the technological process.

Integrating learning about technology into the educational process, although a challenge, is essential to secure our future. If it is not done—well and soon—Minnesotans will fail to keep up with rapid advances in technology which are unconstrained by national boundaries. As important as the notion has been that Minnesotans must be in control of their future, never have the consequences of not being so as great or long-lasting as they are today. Minnesota simply cannot afford to forego the learner goals for technology competence laid out in this report. Indeed, the task force believes that a new focus on technology, its use, development, opportunities, and challenges, is both critical and central to the transformation and improvement of

education as envisioned in recent initiatives of the Minnesota Legislature and State Board of Education.

Technology Competence Defined

In Minnesota, excellent sets of model learner outcomes have been developed for information technology and industrial technology education. The Task Force on Technology Competence reviewed these documents and concluded that they did not address fully its concerns with respect to learning about technology. It concurred with the 1988 report of the Commissioner of Education to the Governor and Legislature, *A Restructured Model for Secondary Vocational Education*, which cited the need for "a curriculum for *all* students to use technology effectively and thoughtfully in all education and lifelong learning experiences." The task force expanded and strengthened this statement and adopted the following definition:

Technology competence is the ability of students to apply knowledge, tools, and skills to solve practical problems creatively, extend human capabilities, and evaluate the impact of technology on themselves and society.

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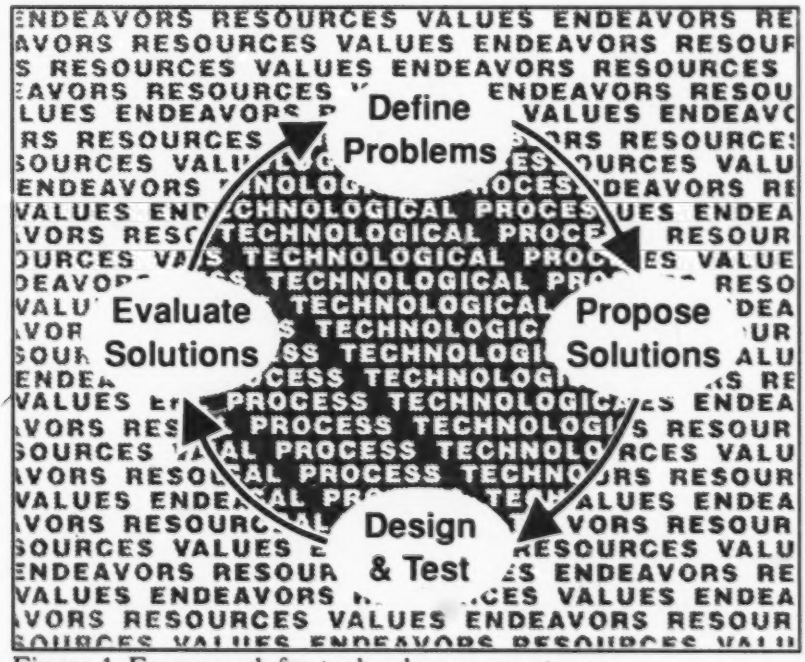

Figure 1. Framework for technology competence.

The concept of technology competence implies the ability to do as well as to know, to demonstrate as well as to understand. It means more than the ability to read a manual or follow prescribed procedures. The phrase "solve practical problems creatively" refers to the ability to apply existing technology in new ways as well as the ability to develop new technology. Practical problems are those in which the central question is "how can one do this?" Examples can be as commonplace as deciding the best way to open a can or as complex as the design of a community or a jumbo jet.

The concept of technology competence implies the ability to do as well as to know, to demonstrate as well as to understand.

Endeavors	Resources	Values
Agriculture	Energy	Aesthetic
Arts & Entertainment	Information	Cultural
Industry & Commerce	History	Ecological
Community Service	Language	Ethical
Education	Mathematics	Moral
Family	Science	Spiritual
Government	Materials	Work
Health, Wellness, & Environment	Tools & Equipment	
Personal Relationships	Wealth	
Recreation & Leisure		
Religion		

Figure 2. Elements of the framework.

Practical problems also involve moral and ethical considerations when the question is rephrased as "what should be done about . . . ?" This is an often overlooked aspect of the technological process. Critical evaluation of technology is an integral part of the definition of technology competence. Knowledge-based judgment skills are essential characteristics of technology competence. This includes an appreciation for the social and environmental impacts of technology such as worker displacement, changes in the structure of families, and the problems of pollution and waste disposal.

A Conceptual Framework for Technology Competence

The conceptual framework for technology competence serves as a reference in interpreting the learner goals and in designing the means for their implementation. The framework

The technological process is summarized by four steps: (a) defining problems, (b) proposing solutions, (c) designing and testing solutions, and (d) evaluating solutions. Each step is affected by the practical problem to be addressed, the resources available to solve the problem, and the values of the culture in which the technological solution is developed and implemented.

elaborates and expands upon the definition laid out by the task force. Furthermore, it highlights technology as a process affecting all human endeavor. The framework centers on the technological problem solving process wherein tools, equipment, human skill, and technological knowledge come together to create technology, solve problems, and expand human capabilities.

The technological process is summarized by four steps: (a) defining problems, (b) proposing solutions, (c) designing and testing solutions, and (d) evaluating solutions. Each step is affected by the practical problem to be addressed, the resources available to solve the problem, and the values of the culture in which the technological solution is developed and implemented.

The elements of the framework shown in figure 2 elaborate upon the three main contextual factors of endeavors, resources, and values. The categories presented are intended to provide a basis for integrating subject matter areas and relating the goals of technology competence to the demands of modern life. The elements of the framework lists are not intended to be all-inclusive. Rather their purpose is to bring greater meaning to the terms used in the framework.

The area of values is of particular importance in the framework. The ethical, moral, and ecological consequences of technology must not be an afterthought in the technological process. These elements must be considered in every step of the process, from developing the initial concepts through marketing and distributing the products and services.

Chapter Two

Technology Competence Attributes of Minnesota High School Graduates

Introduction

The following are broadly defined descriptions of the attributes desired of Minnesota high school graduates relative to technology competence. The rapid pace of technological developments creates an ever-expanding need for a citizenry knowledgeable about technology. The challenge for the educational delivery system is to teach what students need to learn in order to be competent, contributing members of society. These statements were developed by the Task Force on Technology Competence and serve as the foundation for the development of learner goals for technology competence. The attributes are grouped in two sections, the first being *world view attributes* and the second being *practice of technology attributes*.

A student's world view is important. It colors everything the student knows and does. How the student views life, work, leisure, family, and citizenship are affected by these attributes.

World View Attributes of Technology Competence

World view attributes relate to the general outlook and attitude of the student with respect to technology. A student's world view is important. It colors everything the student knows and does. How the student views life, work, leisure, family, and citizenship are affected by these attributes.

Systems View of Technology

The graduate understands the need for various types of technology and realizes that technology is inherently neither good nor bad. He or she understands the interdependent nature of technology and the relationship of technology to the economic, social, and ecological systems upon which humanity depends. The graduate recognizes the many ways in which technology affects his or her life and the lives of others. He or she recognizes the interdependence of science and technology and knows that technology is broad, affecting all human endeavor.

Lifelong Learning about Technology

The development and use of technology require individuals, alone and as members of groups, to make judgments and decisions. . . . Everyone is involved in demonstrating these practices as consumers, workers, family members, students, and citizens.

The graduate recognizes the need to analyze critically the implications of technological trends on career, family, and personal development. He or she sees learning as a continuous, lifelong process. The graduate has an ongoing interest in new developments in technology and undertakes new learning to adapt to and foster change.

Global Perspective of Technology

The graduate embraces the opportunities and possibilities created by worldwide changes in technology. The graduate works with and respects persons whose racial, ethnic, and cultural approach to and usage of technology are different than his or her own. He or she recognizes that the development and use of technology in one part of the world can have dramatic impacts on others.

Historical Perspective on Technology

The graduate understands and appreciates the historical significance of the development of technology. He or she has a broad view of the history of the development of technology and its profound effects on society and the environment, both natural and built. The graduate is able to recount major developments in technology and assess their cultural, social, economic, and ecological impacts.

Practice Attributes of Technology Competence

The development and use of technology require individuals, alone and as members of groups, to make judgments and decisions. The practices of technology reflect the knowledge, skills, attitudes, and values required to participate constructively in economic, political, social, and ecological systems as they relate to technology. Everyone is involved in demonstrating these practices as consumers, workers, family members, students, and citizens.

Acquiring and Managing Information about Technology

The graduate finds, organizes, and retrieves information about technology from a variety of media. He or she is able to identify and access sources as well as to codify, store, and subsequently recall information for use. He or she is generally conversant on (a) the major technological issues facing society and (b) technology used in family, school, work, and other life pursuits.

The graduate knows and uses the language of technology and is able to express the concepts of technology.

Communicating and Technology

The graduate knows and uses the language of technology and is able to express the concepts of technology. He or she formulates ideas and organizes information to elaborate, illustrate, and explain. The graduate is confident and secure in sharing experiences and expressing ideas about technology with others.

Ethically Using Technology

The graduate values the ethical use of technology. He or she uses technology in an ethical manner with respect to social conventions and laws. In daily life and long-term planning, he or she recognizes difficult and sometimes conflicting personal choices regarding the use of technology. The graduate takes into account the effects of the development and use of technology on individuals, society, and the environment.

Relating Technology to the Arts, Humanities, and Social Sciences

The graduate learns that all aspects of the curriculum offer skills and outlooks essential to a modern technological society. This involves attention to technology in the arts and humanities as well as in the social sciences.

Relating Technology to Mathematics and Science

The graduate is literate in mathematics and science and understands their integral relationship to technology. He or she applies mathematics and basic scientific principles in defining, analyzing, and solving technological problems. In some cases the graduate introduces new technologies to advance science.

Developing, Selecting, and Using Technology

Not only is the graduate able to work independently, but also, given the complexity of technology, is able to work as a part of a team.

The graduate selects technology appropriate to the problems and circumstances he or she faces in a variety of contexts and settings. This includes the ability to use a number of different concepts, processes, and tools to solve problems. This ability manifests itself in an understanding of the characteristics of technological systems and associated processes, equipment, and materials.

Creating Solutions through Technology

The graduate identifies and solves problems. He or she anticipates and solves problems through the application and modification of existing technology and the creation of new technology. Not only is the graduate able to work independently, but also, given the complexity of technology, is able to work as a part of a team. He or she applies the technological process to the solution of a variety of problems in daily life.

Critically Evaluating Technology

The graduate critically evaluates technology in terms of its personal, social, environmental, political, and ecological impacts. He or she assesses the risks and benefits of a variety of technological applications and systems.

Relating the Common Good to Technology

The graduate understands the need for public policy regarding the use of technology. He or she takes personal responsibility for the daily use of technology, recognizes the implications of individual decisions on others, and takes social and political actions that contribute to the common good.

Conclusions

The attributes reflect the inter-dependence of human, technological, and natural systems and emphasize the need for assuming personal responsibility in the use and development of technology.

These attributes of a technologically competent high school graduate reflect the need to integrate learning about technology throughout the curriculum since technology impacts all aspects of human endeavor. The attributes require significantly more than the ability to recall and understand facts. Indeed, most of the attributes require higher order processes such as solving problems, creating processes and products, and making critical judgements.

The attributes reflect the inter-dependence of human, technological, and natural systems and emphasize the need for assuming personal responsibility in the use and development of technology. Technology competence, as these attributes show, includes not only knowledge and skills expressed through proficiency but also attitudes and values necessary to apply them in an ethical manner.

Chapter Three

Learner Goals for Technology Competence

Premier Learner Goal

To be technology competent, the learner must demonstrate the world view attributes of technology, apply the practice attributes of technology, and understand the interdependence of the world view and practice attributes of technology.

The attribute statements in this report describe the technologically competent high school graduate. The world view attributes of technology competence relate to the general outlook of the student and affect his or her general approach to technological problems. The practice of technology attributes reflect the knowledge, skills, attitudes, and values required to demonstrate technology competence. The Task Force on Technology Competence emphasizes the importance of both the world view and practice attributes in its premier learner goal for technology competence. The task force said:

To be technology competent, the learner must:

- Demonstrate the world view attributes of technology,
- Apply the practice attributes of technology, and
- Understand the interdependence of the world view and practice attributes of technology.

This premier learner goal should be kept clearly in mind when reading the learner goals which follow. No attempt was made to prioritize the goals as they are all essential to the development of technology competence. Many of the learner goals relate directly to the proposed high school graduation outcomes adopted by the State Board of Education. The task force strongly believes that the learner goals are all necessary to convey completely and properly the meaning of technology competence. As such, they are an integral unit and should not be divided up and placed under different components of the graduation outcomes.

Proposed Learner Goals for Technology Competence

To participate in the use, development, and evaluation of technology, the technologically competent graduate must:

A. Demonstrate a systems view of technology and an appreciation for the interdependence of the social, political, economic, and ecological systems in which it operates.

B. Assess the career, family, and personal development implications of technological change.

C. Demonstrate positive attitudes toward continuous learning about technology.

D. Demonstrate a global perspective with respect to technology, including an appreciation for its potential effects on cultures, geographic areas, and natural and built environments.

E. Apply an historical perspective on technology to the evaluation of the development and use of new technologies.

F. Gather information about technology and critically evaluate its utility and integrity.

G. Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems or satisfy personal needs.

H. Apply legal principles and ethical conduct related to the use of technology.

I. Demonstrate competency in mathematics, science, social sciences, communication, and computer skills through the analysis, design, and evaluation of technological systems.

J. Analyze the potential of alternative technological systems either to solve problems or to extend human capabilities or to do both.

K. Assess the risks and benefits of technological developments from an ecological, economic, social, political, and personal perspective.

L. Value human diversity and work as part of a team in defining technological problems and in suggesting, designing, and testing solutions to such problems.

M. Use a variety of tools, materials, and equipment in solving problems and extending human capabilities.

N. Develop and articulate positions on the relationship of technology to the common good and carry through with them.

Examples of Learning Activities

It is important to note that the task force consistently emphasized the importance of a project approach, with the learners taking leading roles in selecting their projects. Furthermore, the task force stressed the importance of team building and of cooperative, non-competitive learning and work experiences.

The task force saw a need to clarify and elaborate on the learner goals for technology competence. Thus, it developed examples of learning activities as a way of illustrating the meaning of the goal statements. An activity is suggested for each of the goals.

These learning activities are meant to show ways to teach and learn about technology. In reviewing these learning activities, it is important to note that the task force consistently emphasized the importance of a project approach, with the learners taking leading roles in selecting their projects. Furthermore, the task force stressed the importance of team building and of cooperative, non-competitive learning and work experiences.

A. Name: Systems view of technology

Level: High school

Goal: Demonstrate a systems view of technology and an appreciation for the interdependence of the social, political, economic, and ecological systems in which it operates

Exercise: The learner selects a technology (e.g., the telephone) and traces its development and impacts on business, government, geopolitics, individuals, and the natural and built environments. The learner is to consider likely future developments and their potential impacts as well.

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Name: Personal development and technological change

Level: Middle school

Goal: Assess the career, family, and personal development implications of technological change

Exercise: The learner selects a particular occupation (e.g., secretary) and describes the changes in the occupation caused by technology during the last five years and those likely to come in the next five years. Job shadowing is a major part of this activity. The learner is to address the question of whether the occupation will exist in five years.

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C. Name: Attitudes toward learning about technology

Level: Middle school

Goal: Demonstrate positive attitudes toward continuous learning about technology

Exercise: The learner picks a particular occupation (e.g., fire fighter) and documents the ongoing training requirements for the occupation. The learner is to address the relationship between technological developments and education and training.

~ ~ ~ ~ ~

D. Name: Global perspective on technology

Level: High school

Goal: Demonstrate a global perspective with respect to technology, including an appreciation for its potential effects on different cultures, geographic areas, and natural and built environments

Exercise: A group of learners selects a technological issue with global implications (e.g., global warming, nuclear weapons, international banking), gathers information on the issue and related technologies, and analyzes the issue. The learners then convene a mock United Nations, debate the issue, and draft resolutions to address it.

~ ~ ~ ~ ~

E. Name: Historical perspective on technology

Level: High school

Goal: Apply an historical perspective on technology to the evaluation of the development and use of new technologies

Exercise: The learner selects an area of technology (e.g., personal transportation) and describes how it has changed the way people live. The learner is to gain first-hand experience with the technology and document its effects over time. This would include the rise of related technologies and structures to support the fabrication, use, and disposal of the artifacts of the technology (e.g., automobiles, used motor oil).

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F. Name: Evaluating the utility and integrity of technology

Level: High school

Goal: Gather information about technology and critically evaluate its utility and integrity

Exercise: The learner gathers and analyzes information necessary to make a purchasing decision on a specific product (e.g., a personal computer and software). The learner is to evaluate the quality and availability of the information required to make the decision and justify his or her information-gathering and decision-making processes.

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G. Name: Applying diverse technologies

Level: High school

Goal: Apply diverse technologies to store, access, process, create, and communicate information needed to solve problems or satisfy a personal need

Exercise: The learner creates an informational presentation on an extracurricular activity in which he or she is interested (e.g., student government). The learner is to demonstrate competency in the use

of two or more information technologies (e.g., video production, computer graphics).

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H. Name: Ethical use of technology

Level: Middle school

Goal: Legal and ethical conduct and technology

Exercise: The learner evaluates the implications of illegal and unethical conduct with respect to a technology (e.g., violation of copyright law with respect to recorded music). The learner is to (a) address the rationale for the law with respect to unauthorized duplication and (b) to investigate the costs of producing recordings through interviews with industry representatives.

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I. Name: Demonstrating and evaluating technological systems

Level: Middle school

Goal: Demonstrate competency in mathematics, science, social studies, communication, and computer skills through the analysis, design, and evaluation of technological systems

Exercise: The learner applies mathematics to solve a real world problem (e.g., furnishing and decorating a room). The learner is to determine the material requirements and analyze the cost of using a variety of floor and wall coverings. The analysis would include cost comparisons for tile, paint, wallpaper, carpet, linoleum and other materials. The learner is to evaluate the durability of the materials and the environmental consequences of the available solutions.

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J. Name: Analyzing alternative technological systems

Level: High school

Goal: Analyze the potential of alternative technological systems to solve problems and extend human capabilities

Exercise: The learner will compare the benefits and costs of different technologies for accomplishing a given task (e.g., heating a home). The learner is to analyze the costs and environmental impacts of different fuels as well as consider the aesthetics and efficiency of the various available technologies.

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K. Name: Risks and benefits of technological developments

Level: High school

Goal: Assess the risks and benefits of technological developments from ecological, economic, social, and political perspectives

Exercise: The learner assesses the risks and benefits of a technology which impacts society in general (e.g., recycling). The learner is to assess the costs of collection, transportation, and processing of a variety of recyclable items and compare these costs to those of other forms of disposal. This project could include designing a cost effective municipal recycling program.

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L. Name: Human diversity and work in technology

Level: Elementary school

Goal: Value human diversity and work as part of a team in defining technological problems and in suggesting, designing, and testing solutions to such problems

Exercise: Teams of four or five learners are given a common problem to solve (e.g., the design of a new playground). Each team (a) should assess the abilities of its members, (b) devise a strategy for approaching the problem based on these

abilities, and (c) solve the problem. The teams would then come together, evaluate their designs, and formulate a final plan.

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M. Name: Variety in solving problems with technology

Level: Elementary school

Goal: Use a variety of tools, materials, and equipment in solving problems and extending human capabilities

Exercise: The learners observe and participate in an activity in which the same problem is solved using a variety of technologies (e.g., making a hole in a piece of wood). The learners are to examine the capabilities and limitations of a knife, hand drill, power drill, and other boring tools. The learners should consider the utility of the different tools in different situations, (e.g., in the woods, at home, and in a factory).

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N. Name: Technology and the common good

Level: High school

Goal: Develop and articulate positions on the relationship of technology to the common good

Exercise: The learners develop a policy on a technological problem of interest to them (e.g., limited parking spaces for student cars). The learners are to develop policies for solving the problem aimed at maximizing the common good. In the case of student parking, different means of allocating spaces might include student grades, availability of bus transportation, distance the student must travel, and grade level.

Chapter Four

Major Findings and Suggestions for Implementation

The essence of the charge to the Task Force on Technology Competence was expressed by two questions: (a) What should every high school graduate know about technology? (b) How should learning about technology be integrated into the high school curriculum? Answering these questions involved extensive research and thoughtful deliberation on the part of the teachers, business people, scientists, and educators who served on the task force. Their findings and implementation suggestions are presented in this chapter.

Development of technology competence can be part of learning in any subject matter area. Moreover, it should be.

Major Findings

These are the major findings of the task force:

1. Technology is a pervasive force affecting all aspects of human endeavor. It deserves direct consideration throughout the curriculum, and should be part of the education of every student. Despite its importance to the well-being of society and individuals, technology is at present almost an afterthought in the education of most students.
2. Technology competence is the ability of students to apply knowledge, tools, and skills to solve practical problems creatively, extend human capabilities, and evaluate the impact of technology on themselves and society. Development of technology competence can be part of learning in any subject matter area. Moreover, it should be.

3. Technology competence implies more than learning with or about computers. It includes:

   (a) the ability to utilize the processes of problem solving, design, testing, and risk benefit analysis;

   (b) knowledge of the tools, materials, equipment, and other resources employed in the use and development of technology; and

   (c) an understanding of the legal, ethical, and moral dimensions of technological problems.

4. Learning about technology affords students the opportunity to apply mathematics, science, social sciences, and the language arts. Learning about technology also makes these subjects more relevant in demonstrating their relationship to life outside of school, potential career paths, and alternative futures.

5. Technology competence is evidenced by a world view which includes:

   (a) an appreciation for the interdependence of technology and the social, political, economic, and ecological systems in which it operates;

   (b) a positive attitude toward lifelong learning about technology;

   (c) a global perspective on the use and development of technology; and

   (d) an understanding of the significance of technology to human development and history.

Technology needs to be recognized as a legitimate subject of study for every student. . . . The study of technology should emphasize experiential learning through projects and experiences . . . Learning about technology should be a school wide effort . . . Evaluation of student learning for technology competence should focus on authentic student achievements . . . .

Suggestions for Implementation

The task force believes that the manner in which the learner goals for technology competence are achieved is as important as the learner goals themselves. In developing the learner goals for technology competence, the task force gave considerable thought to the question of implementation. The concerns and ideas generated by the task force are summarized in this section.

1. Technology needs to be recognized as a legitimate subject of study for every student. Educators, business and labor leaders, and policy makers must work together to develop technology competence in Minnesota's young

people. Implementation will require major support for the development of curriculum and for the professional development of teachers.

2. The study of technology should emphasize experiential learning through projects and experiences involving individuals, businesses, and institutions in the community. Students should take a leadership role in selecting and conducting learning projects. Learning projects should emphasize problem solving, critical analysis, and design. Students should have the opportunity to work with a wide variety of tools, equipment, materials, devices, and people in learning about technology.

As set forth in this report, technology competence embodies a combination of knowledge, skills, attitudes, and values which present a unique opportunity for (a) integrating the curriculum, (b) transforming the schools, and (c) adding relevance and authenticity to instruction.

3. Learning about technology should be a school wide effort integrating the traditional subject matter areas. Teachers should collaborate in the development and delivery of curriculum for technology competence. To facilitate integration, the structure of the school day needs to be reoriented away from one hour blocks spent in the study of isolated subjects toward scheduling which provides the time needed for integrated instruction and project work.

4. Evaluation of student learning for technology competence should focus on authentic student achievements demonstrated through the products of learning projects. Portfolios of student work coupled with written assessments of student performance are strongly supported by the task force as a principal means for evaluating student learning.

Conclusions

The work of the task force leaves no doubt as to the potential contribution of technology competence to the future of education in Minnesota. As set forth in this report, technology competence embodies a combination of knowledge, skills, attitudes, and values which present a unique opportunity for (a) integrating the curriculum, (b) transforming the schools, and (c) adding relevance and authenticity to instruction.

The framework and learner goals for technology competence provide a solid foundation on which to build a technologically literate and competent citizenry for Minnesota.

Failure in this regard will endanger the state's environment and economy and lessen the quality of life enjoyed by its people.

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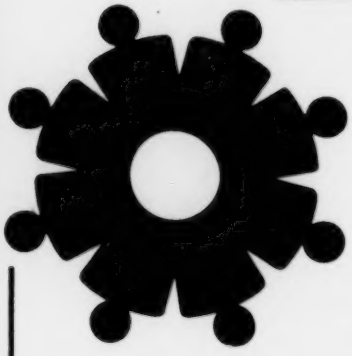

The logo of the State Council on Vocational Technical Education is an abstract representation of the citizen-councilors assembled at a round table. Designed by a commercial art student at Alexandria Technical College, the design was selected in 1982 from 69 entries submitted by vocational students in Minnesota's high schools, secondary cooperative centers, and technical colleges. The Council made its selection on the basis of a recommendation by a panel of representatives from the graphic arts, public relations, and media industries in Minnesota.

Purpose of the Council

The State Council on Vocational Technical Education is designed to further public-private collaboration for the advancement of quality vocational programs responsive to labor market needs. Established in 1969 and designated as a state agency in 1985, the Council comprises 13 members appointed by the Governor. Seven members represent the private sector interests of agriculture, business, industry, and labor. Six of the members represent vocational technical education institutions, career guidance and counseling organizations, special education, and targeted populations.

The Council advises the Governor, the State Board of Technical Colleges, the State Board of Education, the Governor's Job Training Council, the business community, the general public, and the U.S. Secretaries of Education and Labor. The Council advises on development of the annual state vocational plan; provides consultation on the establishment of program evaluation criteria and state technical committees; analyzes the spending distribution and the availability of vocational programs, services, and activities; reports on the extent to which equity to quality programs is provided targeted populations; recommends procedures to enhance public participation in vocational technical education; recommends improvements that emphasize business and labor concerns; evaluates the delivery systems assisted under the Carl D. Perkins Vocational Education Act and the Job Training Partnership Act (JTPA); and advises on policies that the state should pursue to strengthen vocational technical education, as well as initiatives that the private sector could undertake to enhance program modernization.

To enhance effectiveness in gathering information, the Council holds at least one town meeting each year at which the public is encouraged to express its concern about vocational technical education in Minnesota. To enhance its effectiveness in providing information, the Council publishes a quarterly newsletter, an annual directory, and a biennial report. These publications as well as project and activity reports are available to the public.

Information on the date, time, and location of meetings and other activities is available by calling the Council Offices at 612/296-4202.

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